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# Using the Small Telescopes on Tololo to help with DES Calibration?

*Goal: A significant (e.g. 10%) increase in survey efficiency will save money and increase contingency.*

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DES Calibration Workshop  
13 June 2008



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# Small Telescopes at Tololo



Courtesy: NOAO/AURA/NSF



# Before DES Begins... (I)

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## **A DECam CCD in a dewar with robust, stable electronics on one of the small telescopes at CTIO to...**

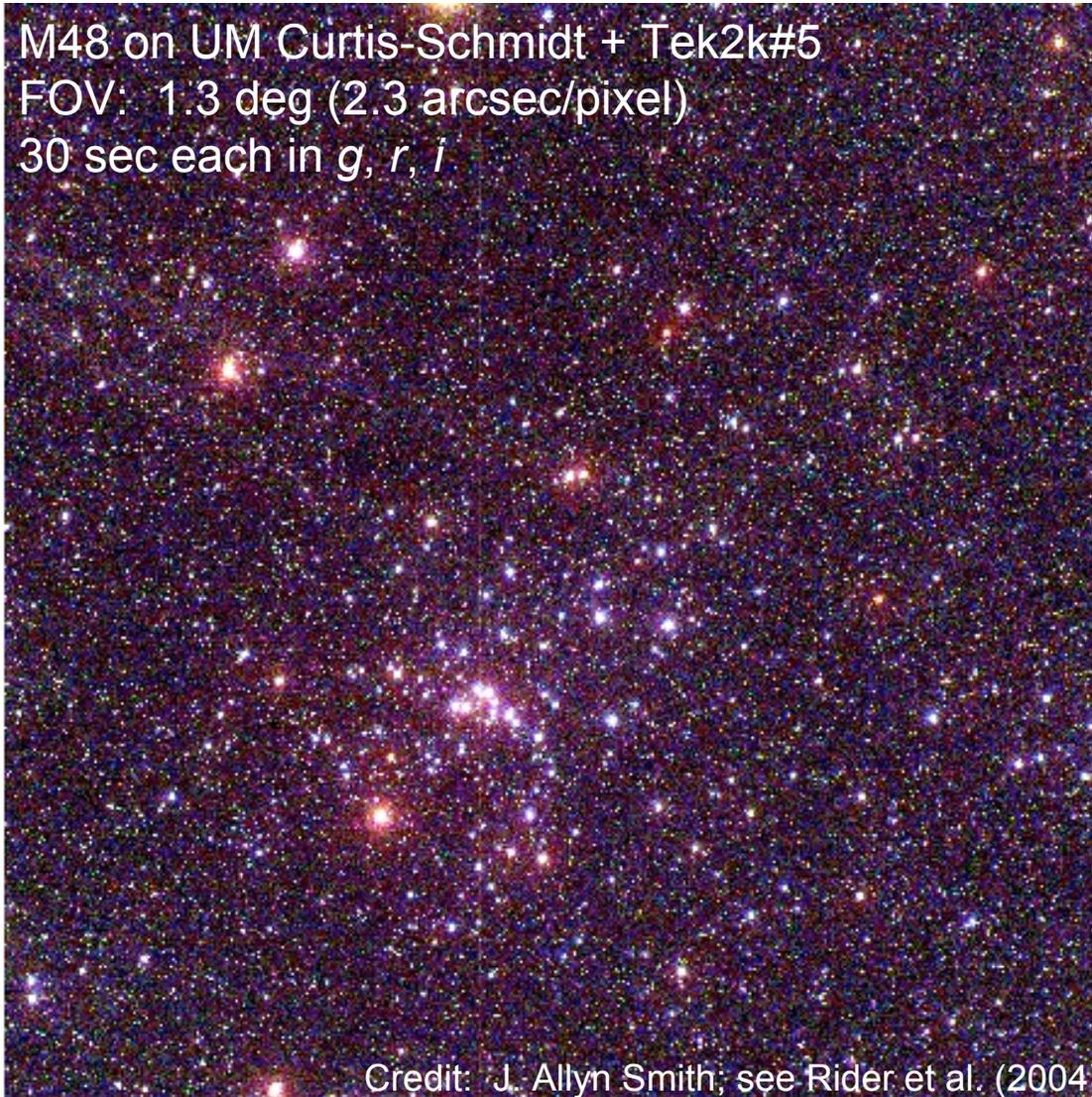
- Stress-test electronics in a real-world environment via relatively lengthy (week-long?) and relatively frequent (several times per year) observing runs
- Measure transformation relations between SDSS *griz* (*g'r'i'z'*) bands and the DES *grIZ* bands (refine after DECam is on Blanco).
- Calibrate DES Z- and Y-band standards (refine after DECam is on Blanco).
- Observe HST spectrophotometric standards (esp. hot WDs) for calibration to AB system.
- Find fainter hot WDs in the DES SN fields.
  - Also need *u*-band plus spectroscopic follow-up



## Before DES Begins... (II)

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M48 on UM Curtis-Schmidt + Tek2k#5  
FOV: 1.3 deg (2.3 arcsec/pixel)  
30 sec each in *g*, *r*, *i*



Credit: J. Allyn Smith; see Rider et al. (2004)

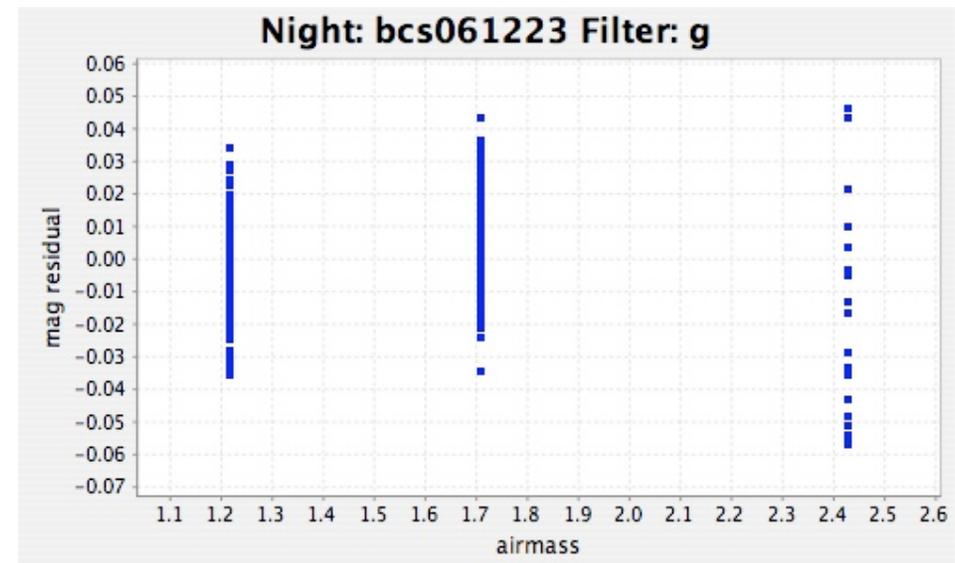
- Install a mosaic of four DECam 2k x 2k CCDs on UM Curtis-Schmidt (=“PreCam”?)
- FOV of  $1.6^\circ \times 1.6^\circ$  (2.56 sq deg) at a pixel scale of 1.4 arcsec/pixel (15 $\mu$  pixels)
- At 2 min/exposure (plus overhead), can image the 5000 sq deg of the full DES footprint in DES *grIZY* in less than 2 months.
- Bright (~17th mag) survey of the DES footprint.
- Stress-test of DTS, survey strategy, survey software, hardware, and electronics.
- Rough standard star network, sufficient for realtime QA of the DECam chips during DES operations.
- Add *u*-band to get candidate hot WDs for absolute calibration of DES.



# Current DES Strategy for Standard Star Observations

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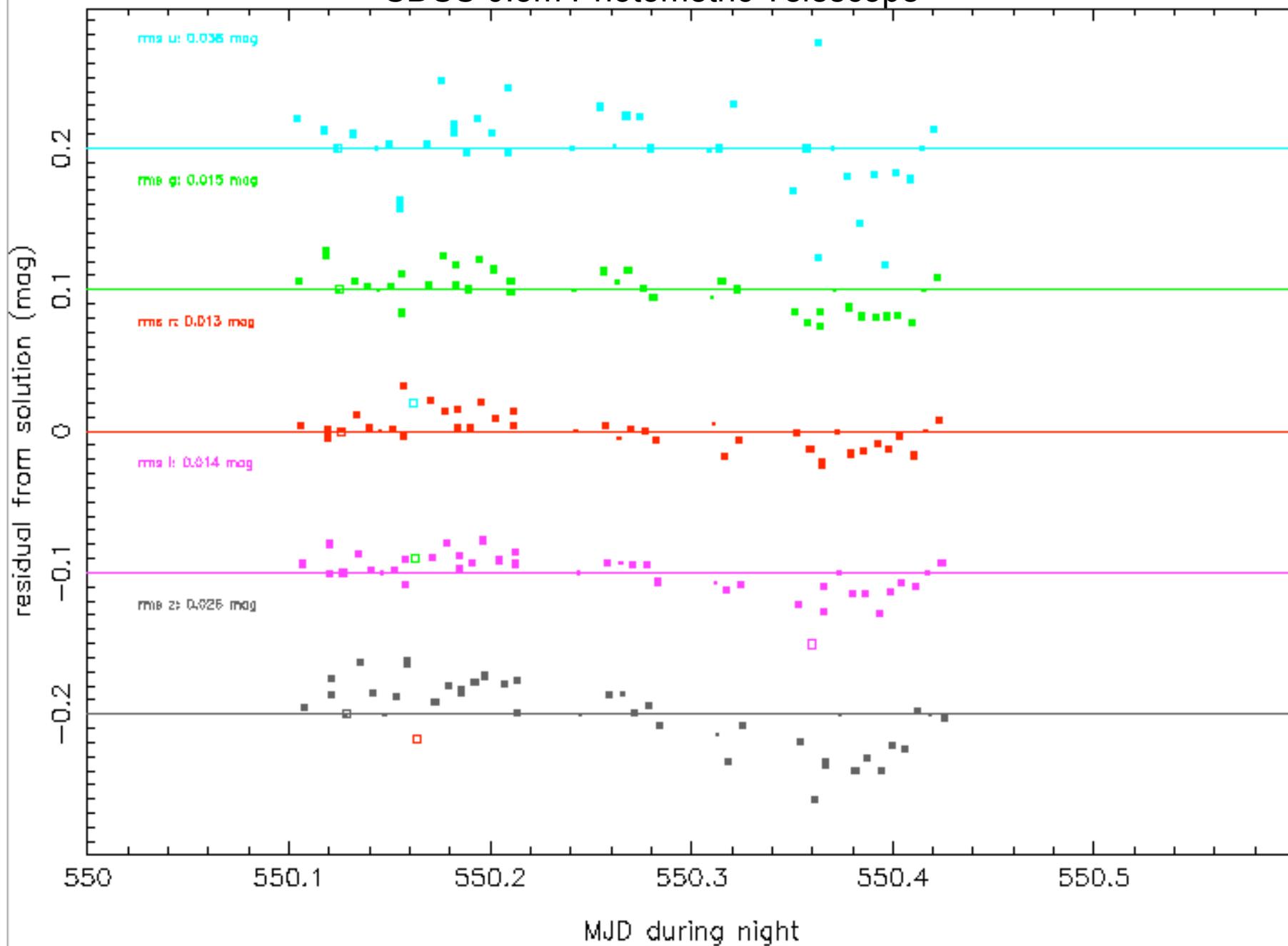
- Observe 3 standard star fields, each at a different airmass ( $X=1-2$ ), between nautical ( $12^\circ$ ) and astronomical ( $18^\circ$ ) twilight (evening and morning).
- Observe up to 3 more standard fields (at various airmasses) throughout the night
- Also can observe standard star fields when sky is photometric but seeing is too poor for science imaging (seeing  $> 1.1$  arcsec)
- Use fields with multiple standard stars (to cover focal plane and to cover a wide range of colors)
- Keep an eye on the photometricity monitors



**Result: not a very good sampling of extinction in the time domain**

mag residuals for primary standard stars in run 54550

### SDSS 0.5m Photometric Telescope





# During DES Operations...

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## A DECam CCD in a dewar with robust, stable electronics on one of the small telescopes at CTIO to...

- Act as an extinction monitor
  - No need for Blanco to observe multiple standard star fields per night
  - Still need to observe one standard field once per night (probably during twilight) to measure photometric zeropoints (“*a*” terms) and instrumental color (“*b*”) terms.
  - Yields an extra hour every night for the Blanco to do something else, assuming about half an hour between 12° and 18° twilight in the evening and the morning, plus some more time in the middle of the night
    - Observe Z- and Y-band **science** fields during twilight (this is what LSST plans to do)
    - 1 hour per night ~ 10% of observing time ~ 52.5 nights x \$10K/night = \$525,000.
  - Set first-order extinction (“*k*”) coefficients for night in the Photometric Standards Module as measured by small telescope.
    - More robust measure of nightly extinction than could be done with the limited time available for standard star observations on Blanco; could even measure a time variable extinction ( $dk/dt$ )
    - This is even done by SDSS Uebecal (using *k* and  $dk/dt$  as measured by the SDSS Photometric Telescope)
    - **Not** suggesting that we use the small telescope to do “Secondary Patches” *a la* the SDSS standard calibration.



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# Extra Slides